

## Claims

We claim:

1. A phase delay line, comprising:
  - an RF transmission line;
  - a structure defining a fluid channel having a serpentine configuration coupled to said RF transmission line along at least a portion of a length of said transmission line;
  - and
  - at least one variable displacement fluid processor for changing a distribution of a fluidic dielectric within said fluid channel in response to a phase delay control signal;
  - wherein a phase delay of said transmission line is selectively varied by changing said distribution of said fluidic dielectric in said fluid channel.
2. The phase delay line according to claim 1 further comprising a second fluidic dielectric within said fluid channel, said first fluidic dielectric having at least one of a first permittivity and a first permeability that is different respectively from at least one of a second permittivity and a second permeability of said second fluidic dielectric; and wherein said at least one variable displacement fluid processor changes a distribution of said first and second fluidic dielectric relative to said transmission line.
3. The phase delay line according to claim 2 wherein said first and second fluidic dielectrics are immiscible.
4. The phase delay line according to claim 2 wherein said first and second fluidic dielectrics are separated by an immiscible fluid interface.
5. The phase delay line according to claim 3 wherein said fluid channel extends along a length of said transmission line and said distribution of said first and second fluidic dielectrics is varied along a length of said fluid channel.

6. The phase delay line according to claim 1 wherein said fluidic dielectric has a permeability and a permittivity selected for maintaining a constant characteristic impedance along an entire length of said RF transmission line.
7. The phase delay line according to claim 1 wherein said transmission line is also coupled to a solid dielectric substrate material.
8. The phase delay line according to claim 7 wherein said solid dielectric substrate is formed from a ceramic material.
9. The phase delay line according to claim 7 wherein said solid dielectric substrate is formed from a low temperature co-fired ceramic.
10. The phase delay line according to claim 1 wherein said variable displacement fluid processor comprises at least one high volume pump for coarse adjustment of said distribution and one low volume displacement pump for fine adjustment of said distribution.
11. The phase delay line according to claim 2 wherein said variable displacement fluid processor comprises at least one fluid conduit for communicating each of said first and second fluidic dielectrics to said fluid channel.
12. The phase delay line according to claim 11 further comprising a first fluid port communicating said first fluidic dielectric from said conduit to said fluid channel portion and a second fluid port communicating said second fluidic dielectric from a second conduit to said fluid channel portion, and an immiscible fluid interface separating said first and second fluidic dielectrics.
13. The phase delay line according to claim 1 wherein said fluidic dielectric is comprised of an industrial solvent.
14. The phase delay line according to claim 1 wherein at least one component of said fluidic dielectric is comprised of an industrial solvent that has a suspension of magnetic particles contained therein.

15. The phase delay line according to claim 14 wherein said magnetic particles are formed of a material selected from the group consisting of ferrite, metallic salts, and organo-metallic particles.

16. A phase delay line, comprising:

an RF transmission line;  
a structure defining a fluid channel having a serpentine configuration coupled to said RF transmission line along at least a portion of a length of said transmission line;  
and

at least one variable displacement fluid processor for changing a distribution of a fluidic dielectric within said fluid channel in response to a phase delay control signal;

wherein a phase delay of said RF transmission line is maintained constant as an operational frequency of said RF transmission line is varied, said phase delay maintained constant by changing said distribution of said fluidic dielectric in said fluid channel.

17. A method for producing a phase delay for an RF signal comprising the steps of:

propagating said RF signal along an RF transmission line; and  
positioning a fluidic dielectric within a fluid channel having a serpentine configuration and being coupled to said RF transmission line along at least a portion of a length of said transmission line, said fluidic dielectric being positioned to selectively control said coupling to vary a phase delay of said transmission line.

18. The method according to claim 17 further comprising the steps of:

positioning a second fluidic dielectric within said fluid channel, said first fluidic dielectric having at least one of a first permittivity and a first permeability that is different respectively from at least one of a second permittivity and a second permeability of said second fluidic dielectric; and

changing a distribution of said first and second fluidic dielectrics relative to said transmission line.

19. The method according to claim 17 wherein said first and second fluidic dielectrics are immiscible.
20. The method according to claim 17 wherein said first and second fluidic dielectrics are separated by an immiscible fluid interface
21. The method according to claim 20 wherein said fluid channel extends along a length of said transmission line and said distribution of said first and second fluidic dielectrics is varied along a length of said fluid channel.
22. The method according to claim 17 further comprising the step of also coupling said RF transmission line a solid dielectric substrate material.
23. The method according to claim 22 further comprising the step of forming said solid dielectric substrate from a ceramic material.
24. The method according to claim 22 further comprising the step of selecting a material for said solid dielectric substrate to be a low temperature co-fired ceramic.
25. The method according to claim 22 further comprising the step of selecting said fluidic dielectric to have at least one of a permittivity and a permeability that is different as compared to said solid dielectric substrate.
26. The method according to claim 17 further comprising the step of selecting said fluidic dielectric to have at least one of a permeability and a permittivity selected for maintaining a constant characteristic impedance along a length of said RF transmission line.
27. The method according to claim 17 further comprising the step of selecting a material for said fluidic dielectric to include an industrial solvent.
28. The method according to claim 17 further comprising the step of selecting a material of said fluidic dielectric to include an industrial solvent that has a suspension of magnetic particles contained therein.

29. The method according to claim 27 further comprising the step of selecting said magnetic particles from the group consisting of ferrite, metallic salts, and organo-metallic particles.

30. A method for producing a phase delay for an RF signal comprising the steps of:

propagating said RF signal along an RF transmission line; and  
positioning a fluidic dielectric within a fluid channel having a serpentine configuration and being coupled to said RF transmission line along at least a portion of a length of said transmission line, said fluidic dielectric being positioned to maintain a constant phase delay as an operational frequency of said RF transmission line is varied.